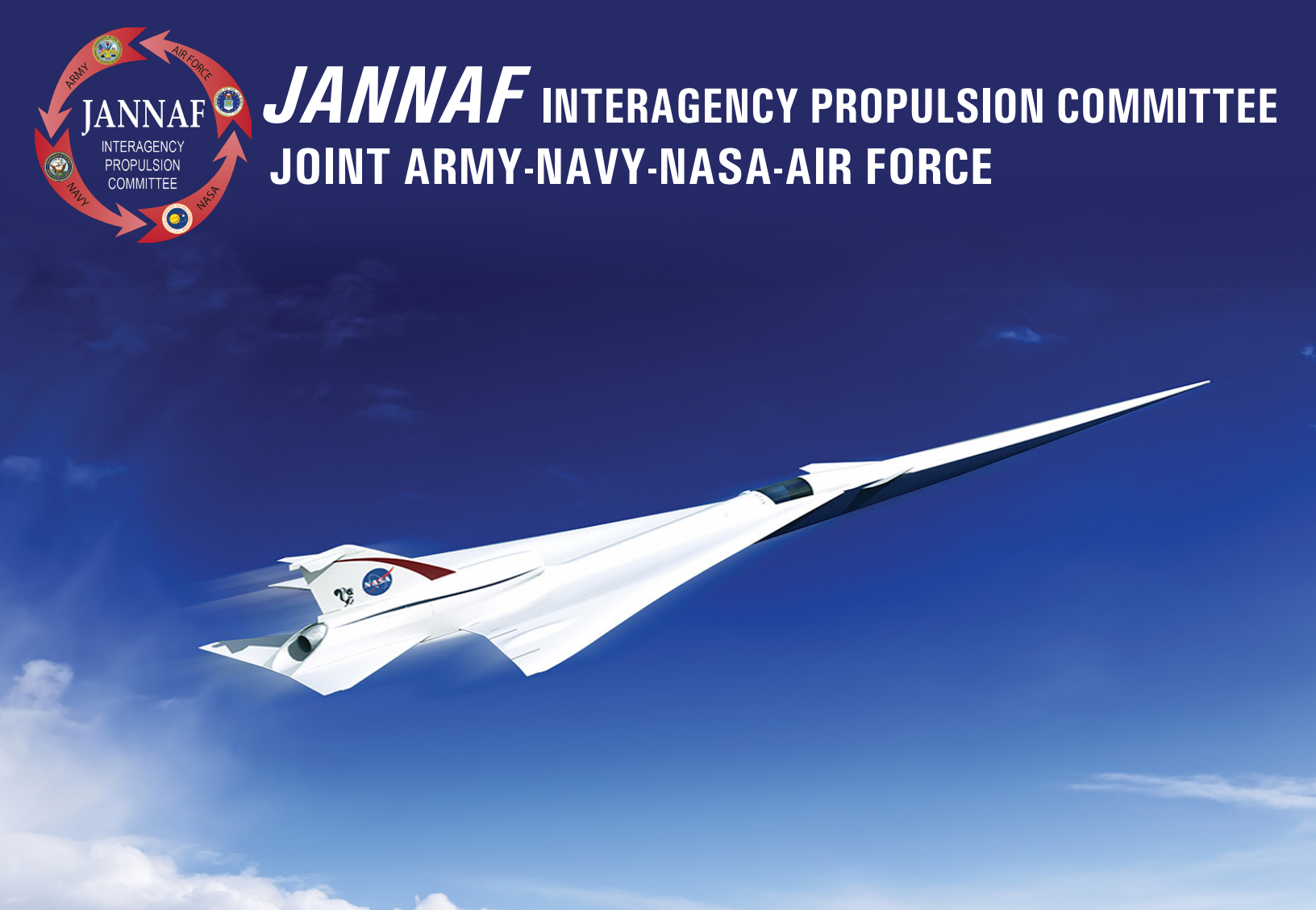
JANNAF INTERAGENCY PROPULSION COMMITTEE
JOINT ARMY-NAVY-NASA-AIR FORCE



ANNOUNCEMENT & CALL FOR PAPERS

13th Modeling & Simulation (MSS)
11th Liquid Propulsion (LPS)
10th Spacecraft Propulsion (SPS)
JOINT SUBCOMMITTEE MEETING
Programmatic & Industrial Base Meeting (PIB)

9-13 DECEMBER 2019
FLORIDA

Extended Abstract Deadline: 8 July 2019

last updated 06/10/2019

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The December 2019 meeting of the Joint Army-Navy-NASA-Air Force (JANNAF) will consist of the Joint Meeting of the 13th Modeling and Simulation / 11th Liquid Propulsion / 10th Spacecraft Propulsion Subcommittees, and the Programmatic and Industrial Base Meeting. Dr. Hani Kamhawi with the NASA Glenn Research Center, Cleveland, OH, is the Meeting Chair. This meeting will be held **Monday through Friday, 9 - 13 December 2019**, at a Florida location to be announced.

ATTENDANCE REQUIREMENTS

The overall security level of the meeting is **Unclassified**. All sessions will be held at the selected hotel, to be announced. Attendance, applicable to presenters as well, is restricted to invited U.S. citizens qualified to receive unclassified, limited-distribution information. *No foreign nationals are permitted to attend.*

ALL non-government attendees (which includes contractors, consultants and universities) attending this meeting **must:**

1. Be working on a current government contract or certified by a Sponsoring Government Official
2. Provide their organization's DD 2345 Certification Number for receipt of militarily-critical technical data

DD 2345: For additional information, contact the Joint Certification Program Office (JCP) at 1-800-352-3572 or visit their Web site at http://www.dla.mil/HQ/InformationOperations/Offers/Products/LogisticsApplications/JCP.aspx.

ALL Attendees: To register, you must first have a JANNAF Secure Portal account. Please visit the Registration page of the meeting website for additional information and important links. *All presenters are required to register and pay the registration fee.*

Questions concerning attendance eligibility should be directed to the JANNAF Security Team, Mary Gannaway (mtg@jhu.edu) or Tricia Reider (treider@erg.jhu.edu) or by calling (410) 992-7300.

PURPOSE

The JANNAF Interagency Propulsion Committee focuses on the technology, development, and production capabilities for all types of propulsion systems and energetics for tactical, strategic and missile defense rockets and missiles, for space boost and orbit transfer, for in-space propulsion, and for gun systems. JANNAF provides a forum for discussion of propulsion issues, challenges, and opportunities across the Military Departments, Defense Agencies and NASA. JANNAF subcommittees focus their resources on technical issues of interest to the JANNAF agencies.

Work in all areas of DoD and NASA are solicited as defined below:

6.1 Basic Research:
Systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products.

6.2 Applied Research:
Systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met.

6.3 Development:
Systematic application of knowledge toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements.

JANNAF accepts papers that are unclassified/unlimited and unclassified/limited for all meetings; and up to classified Secret as announced in the specific meeting's announcement and call for papers.

SCOPE

To learn more about the scope of the standing JANNAF subcommittees at this meeting, please review the information provided below and on pages 5-12.

Modeling and Simulation Subcommittee

The 13th MSS activities include model based engineering (modeling and simulation of systems, software analogs of systems, integrated system simulations, system-of-systems analysis and simulation); simulation credibility-uncertainty, verification, validation, reliability, and risk; and integrated health management-identification and management of off-nominal conditions in propulsion.

Liquid Propulsion Subcommittee

The 11th LPS is seeking papers on the advancement of liquid engine systems, technical problems and issues associated with the design, analysis, fabrication and testing, including liquid and gel propulsion technology topics that include the overall engine system, combustion components, turbomachinery and propellant feed systems.

Spacecraft Propulsion Subcommittee

The charter of the Spacecraft Propulsion Subcommittee addresses technical problems and issues of national needs associated with technology materials applied to space-based primary or auxiliary propulsion. These issues (for both system and component level) include design, development, materials, lifetime, performance, ground testing, flight testing, validation, qualification, spacecraft integration, fabrication processes, standards and cost. The 10th SPS seeks abstracts on the full array of spacecraft propulsion technology interests including chemical propulsion, electric propulsion, micropropulsion, nuclear thermal propulsion, propellant management, aerocapture, solar sails, solar thermal propulsion, tether systems, in-space propulsion infrastructure, and technologies for the future. Possible applications to these technologies are orbit to orbit transfer, attitude control, non-terrestrial ascent/descent, station keeping, deep space, formation flying, drag makeup, and orbital rephasing.

Programmatic and Industrial Base

The JANNAF Programmatic and Industrial Base (PIB) Committee was created with the approval of the JANNAF Charter by the Department of Defense and the National Aeronautics and Space Administration in 2014. Its focus is on providing a mechanism for DoD and NASA to collaboratively identify and manage risks and issues within the propulsion industrial base, and to work together to solve them. This requires an integrated understanding of each program's plans and key decision points, and how those decisions may impact the propulsion industrial base. PIB activities include industrial base assessments, which identify risks and opportunities with respect to skills, knowledge, and experience; identification of commonality, innovative acquisition, and partnership opportunities; integrated assessments to identify rocket propulsion industrial base (RPIB) rationalizational opportunities; special actions from senior agency, department, or Executive Office of the President (EOP) leadership; and information provided to decision makers for either situational awareness or policy decisions.

ABSTRACT SUBMITTAL INSTRUCTIONS

- The technical areas to be addressed are defined in this announcement. Individuals who wish to submit an abstract should carefully review the topic areas listed on pages 5-12.
- The submission of an abstract represents an agreement to submit a final paper for publication by **11 November 2019**, attend the meeting, and deliver a 30-minute presentation. Your presentation will be heard by all qualified individuals within industry, government, and university organizations. *If your paper cannot be presented to all qualified attendees, it cannot be presented in this program without specific approval from members of the JANNAF Technical Executive Committee.*
- Submit only unclassified abstracts. **Abstracts will not be published** and will only be used by the program committee members for paper selection purposes.
- Limit the abstract to 250-300 words and exclude tables and figures. State the objective of the work. Describe the scope, method of approach, and any new advances in the state of the art. Highlight important conclusions, and include a brief summary of the data used to substantiate them.
- Please submit using the Abstract Submittal Form, which can be downloaded from the December meeting website.
- Indicate confirmation of management support on the Abstract Submittal Form to *ensure availability of resources for your participation in the meeting*. This is NOT related to security review/approval to submit the abstract or submit/present the paper.
- **Many organizations require abstracts to be processed through an approval system prior to submission.** This process takes additional time, so authors should **plan accordingly and begin the process early in an effort to meet the abstract deadline date.**
- Remember, ***you must be an invited and qualified U.S. Citizen to attend and present at this meeting***. No foreign nationals are permitted to attend.
- The **Extended deadline** date for submission of completed Abstract Submittal Forms to JHU WSE ERG is **8 July 2019.**

JHU WSE ERG accepts only **electronic submission** of abstracts and papers. **Abstracts must be submitted on the** Abstract Submittal Form**:**

- Via email to: meetings@erg.jhu.edu *(Distribution A only)*; **OR**
- Uploaded to the ERG secure server as follows:

1. Go to https://webdatabase.cpia.jhu.edu/docorg/program/cgi-bin/Login.pl
2. **Choose Infobase:** JANNAF Mtg Abstract Uploads
3. **Type in User Name:** Abstract
4. **Type in Password** [contact ERG at (410) 992-7300 or 7302 for current password, changed daily]
5. Click the "Login" button
6. Click on "December 2019 JANNAF Meeting"; choose "Add Document" (to the left of the screen)
7. Complete the "Add Document" form, being sure to Title your Document, select "Upload from Client", click the "Browse" button and navigate to where you have saved your completed Abstract Submittal Form on your computer. Select the file and click "Open". Choose the appropriate file format (MS Word or PDF) under Document Type, and click on "Apply".
   ***NOTE:* The upload site does not send a confirmation. To verify that your upload was successful, click the refresh button in your browser.
8. Email meetings@erg.jhu.edu to notify that the file has been successfully uploaded.

MSS / LPS / SPS / PIB AUTHOR TIMELINE

Week of	Weeks before Meeting	Action
8 July 2019	26	Extended Deadline for receipt of Abstract Submittal Forms.
12 Aug 2019	17	Acceptance/rejection letters sent to authors.
2 Sep 2019	14	Deadline for changes to Meeting Invitation and Preliminary Program.
16 Sep 2019	12	Invitation, Preliminary Program, and registration materials forwarded to propulsion community.
7 Oct 2019	9	Deadline for award nominations and submittal of Student papers for Best Student Paper award consideration.
28 Oct 2019	6	Deadline for submission of changes to the Final Program.
11 Nov 2019	4	Deadline for receipt of papers and paper/ presentation clearance forms. **Papers not received by this date may be removed from the program.**
18 Nov 2019	3	Anticipated deadline for reservations at host hotel.
25 Nov 2019	2	Deadline for receipt of presentations.
6 Dec 2019	1	Deadline for completion of online Registration Form. Deadline for reduced registration fee
9 Dec 2019	0	Start date for MSS/ LPS/SPS/PIB Joint Subcommittee Meeting

RECOMMENDATIONS FOR WORKSHOPS OR SPECIALIST SESSIONS

Recommendations for workshops or specialist sessions are solicited at this time. Individuals interested in organizing and chairing a workshop or specialist session should contact the JHU WSE ERG Technical Staff member in their respective subcommittee with suggestions for topics by **10 June 2019**. See pages 12-13 for additional information and requirements.

AWARDS

Nominations for JANNAF Technical Executive Committee (TEC), PIB Executive Committee (PEC), MSS, LPS and SPS recognition awards are being solicited. Individuals interested in nominating an award recipient should follow the guidelines and instructions on pages 13-14.

HOTEL INFORMATION

Discounted rooms at the region's government per diem rate are being arranged for all JANNAF attendees at the host hotel in Florida. Please visit the Hotel page of the website for more information; details will be announced soon.

Some top reasons given for attending JANNAF meetings:

- **The opportunity to present limited distribution papers to a technical audience and collaborate with colleagues from other laboratories and companies.**
- **Networking opportunities with other scientists.**
- **Lessons learned presentations.**
- **Keeping up with changing technology.**
- **Wide variety of subjects.**
- **Great exposure to the industry for young professionals.**

SUBCOMMITTEES / MISSION AREAS AT THIS MEETING

Click on the Mission Area of interest in the chart below to jump to that section in this Call for Papers.

Mission Area	MSS	LPS	SPS
I	Model-Based Engineering	Liquid Engine Systems	Chemical Propulsion
II	Integrated Health Management	Liquid Combustion Subsystems and Components	Electric Propulsion
III	Simulation Credibility: Uncertainty, Verification, Validation, and Risk	Liquid Propellant Feed and Pressurization Systems	Cube / Nano Satellite Propulsion
IV	Modeling and Simulation of System Autonomy	Advanced Materials for Liquid Propulsion Applications	Future Technologies

MSS MISSION AREAS

The Modeling and Simulation Subcommittee (MSS) provides an overarching focus on M&S across all disciplines related to JANNAF Interagency simulation-based acquisition of propulsion systems for aerospace plane, hypersonic aircraft, rocket-based space-access systems, high-speed missiles, and in-space propulsion systems, and gun propulsion systems. Model-Based Engineering, Integrated Health Management, and Simulation Credibility Panels of MSS pursue this focus in the following current mission areas: Model-Based Engineering, Integrated Health Management, Simulation Credibility, and Modeling and Simulation of System Autonomy. At the 13th MSS Meeting, papers are sought to address specifics of these mission areas as described below.

Mission Area I: Model-Based Engineering

Chair: Mr. Eric J. Paulson, AFRL / Edwards AFB, CA

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Model-Based Engineering (MBE) encompasses the development of methodologies, codes, and model simulations to quantitatively evaluate and optimize propulsion technologies across propulsion component, propulsion system, and vehicle system levels. The MBE mission area includes the specific discipline of Model-Based System Engineering (MBSE). MBSE is the formalized application of modeling to support system requirements, design, analysis, and verification/validation activities from conceptual design through later life cycle phases. The use of models complements traditional experimentation during technology development with a goal of reducing the development time and schedule. Development and usage of physics-based models allows exploration of domains and behaviors that may be particularly difficult or impossible to examine experimentally. Publications in the MBE area fall under two topic headings: Modeling Methodologies/ Approaches/Tools and System Analysis Results.

Examples of topics of interest for the MBE mission area include the following:

- Modeling Methods/Approaches
  - Proposed performance/loss models for rotating detonation rocket engines analogous to the JANNAF standard for constant pressure liquid rocket engines
  - Accommodating multidisciplinary modeling at multiple hetergeneous levels of fidelity
  - Engineering decision support, including facilitating optimization, scheduling, and knowledge-based tool integration into the engineering process
  - Advances in the development of models and methods for component modeling and simulations to aid propulsion design
  - Improvements in commercial software which enable advanced MBE
  - Challenges/Boosts to using MBE under a more commercial/less centralized propulsion technology development paradigm and shifts from horizontal to vertical integration in the launch industry
- System Analysis Results
  - M&S of vehicle system technology trades for space launch systems, prompt strike platforms, long-range ballistic missiles, cruise missiles, and hypersonic cruise vehicles
  - Simulations, methods, and models to evaluate performance capabilities, cost, and reliability of systems
  - Vehicle and launch facility, weapon and weapons platform, propulsion system and test facility simulations, interactions, and integration

Mission Area II: Integrated Health Management

Co-Chairs: Mr. R. Scott Hyde, Northrop Grumman Corporation / Brigham City, UT
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Integrated Health Management (IHM) promotes advancement and development of best practices for IHM of propulsion systems within a "system of systems" environment. IHM technologies are focused on reducing maintenance and logistics costs, and increasing reliability of propulsion systems. IHM includes methods and tools for: data management and mining; integrated communications, command and control; diagnostics; prognostics, and integrated sensors and sensing systems. These tools enable making redline and contingency decisions using knowledge-based expert systems, model-based diagnostic and reasoning, fault models, neural networks, fuzzy logic, genetic and evolutionary algorithms, and life-cycle analysis. The advancement of the internet of things (IoT), digital twin and augmented reality (AR) technologies are key enablers for implementing IHM in propulsion systems.

Seeking papers on the following, with the intent to establish a valuable interchange of technical solutions:

- IoT, Digital Twin and AR implementation challenges, successes, lessons learned and business case impact.
- Data Management and Mining: Advances in data mining, data fusion, machine learning, and statistics with applications to verification and validation of data, prognosis and diagnosis of system health.
- Integrated Communications, Command and Control: architecture, theory, test beds, and demonstrations.
- Diagnostic Systems: architecture, theory, simulations, and demonstrations of diagnosis of current state of health of propulsion and vehicle system.
- Prognostic Systems: architecture, theory, simulations, and demonstrations of prognosis of future state of health of propulsion and vehicle systems; mitigation of, and recovery from, degraded system health to enable condition based repairs and successful missions.
- Integrated Sensors and Sensing Systems: sensors and integrated sensing systems with broad applications including human health, aircraft, ground vehicles, ships, and energy, and methods for integrated sensing systems across multiple disciplines and end-use applications with an emphasis on measurement technology, smart sensors, test beds, application considerations, lessons learned, and sensor fidelity.

Mission Area III: Simulation Credibility: Verification, Validation, and Uncertainty Quantification

Co-Chairs: Dr. Robert Baurle, NASA LaRC / Hampton, VA
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The credibility of digital simulations is a major issue for incorporating simulation tools and data into a technology-development program, for conducting simulation-based acquisition, for assessing system reliability to assure human safety and/or mission success, and for identifying and assessing risks in complex, technological systems. Simulation credibility includes assessment and quantification of simulation uncertainty, sensitivity analysis, experimental uncertainty, physical model validation, simulation verification and validation, and risk assessment. Papers are solicited on efforts and guidance on simulation credibility for unit, benchmark, subsystem, and system problems related to the following topics:

- Uncertainty sources and sensitivity analysis
- Propagation, quantification, and management of uncertainty
- Simulation verification
- Model validation
- Simulation credibility assessment
- Risk assessment and management
- Best practices, guidelines, and procedures for establishing simulation credibility.

Mission Area IV: Modeling and Simulation of System Autonomy

Chair: Dr. Michael D. Watson, NASA MSFC / Huntsville, AL
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Modeling and Simulation of System Autonomy encompasses the development of methodologies, codes, and models, and simulations to evaluate, analyze, and optimize autonomous system capabilities. System autonomy addresses the modeling and simulation of artificial intelligence (AI) algorithms, the integration of AI algorithms, simulation environments including the interaction of algorithms with system hardware, verification and validation of non-deterministic algorithms, and determination of operational bounds. The use of modeling and simulations of autonomous systems to determine their

responses and operational bounds is also a crucial technology area. Various autonomous systems are included in this mission area including aircraft, ground vehicles, hypersonic vehicles, launch vehicles, spacecraft, and water craft.

Modeling and Simulation Subcommittee Chair

Dr. Michael D. Watson, NASA MSFC / Huntsville, AL

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JHU-WSE ERG Technical Representative

Mr. Alex Bishop, JHU WSE Energetics Research Group / Columbia, MD

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LPS MISSION AREAS

The JANNAF 11th Liquid Propulsion Subcommittee meeting will include sessions in four general technical areas: liquid engine systems; liquid combustion subsystems and components; liquid propellant feed and pressurization systems; and advanced materials for liquid propulsion applications. Papers are solicited that will aid in the design, development and test of efficient and stable liquid propulsion systems.

Mission Area I: Liquid Engine Systems

Co-Chairs: Mr. John W. Peugeot, NASA MSFC / Huntsville, AL

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Mr. Nils M. Sedano, AFRL / Edwards AFB, CA

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System Models, Analysis, and Data Integration: Analytical tools, system models, and methodologies that create a digital thread of the liquid engine lifecycle. Specific interest in analyses or data integration that enable greater comprehension of system interactions and dependencies; MBE/MBSE architectures, design verification and traceability, risk identification, management of idea margins, test data anaylsis, and prediction of integrated-system performance, mass, and cost.

Concurrent Engineering and Design: Areas associated with operations, maintenance, and asset life. Architecture Con-Ops functional analysis, and designs that improve the efficiency of launch operations or develop a capability for in-space operations.

- Operability - technologies and designs that increase automation, provide resilient/launch-on-demand capabilities, or enable use over a wider range of environments and applications.
- Serviceability - rapid inspection, diagnostics, cleaning, remove-and-replace, etc. that improve launch availability through responsive anomaly resolutions.
- Modularity - Engine architectures, technologies, and designs that increase the scalability, applicability, and economies of scale of liquid rocket engines to reduce development timelines and Non-Recurring Engineering costs.
- Reusability - Design for long in-space missions; 25+ engine firings, refueling operations, system diagnostics, and servicing of critical components.

Liquid Engine Systems for Small Launch Vehicles and Landers: Design, development, test, and evaluation approaches for liquid propellant rocket engines applicable to small landers and launch vehicle stages: reliability, fabrication, testing, operations, and the affordable integration of those areas. Systems that enable autogenous pressurization, deep throttling capability, cryogenic RCs, or wireless instrumentation and controls are of particular interest.

Liquid Engine Systems for Human-Rated Stages and Landers: Design, development, test, and evaluation approaches and planning associated with liquid propellant rocket engines for use on human-rated vehicles; including Lunar and Mars landers, commercial space applications, and NASA's Space Launch System (SLS). Functional requirements and design concepts and/or design modifications for the engines on these vehicles. Approaches for meeting government (NASA, FAA, or OCST) safety and reliability requirements for operation with a crew and passengers, including fault tolerance, fault detection, isolation, and recovery; crew interaction, reliability predictions and models, and qualification/certification testing requirements and approaches.

Liquid Rocket Engine (LRE) Development History: Papers addressing the important process which LRE have gone through in the course of their development. Particular subjects of note are successes, failures, mishaps, and lessons learned. Topics can be detailed in their information or can provide a general overview of the program. Papers are not limited to flight systems; testbeds, proof-of-concepts, and R & D programs are encouraged as well.

Test Practices, Standards, and Facilities: Industry-consensus best practices and standards for the test and evaluation of liquid engines, components and propulsion/vehicle interaction. Status, capabilities, and operation of government and commercial rocket engine test facilities. This includes training, problem reporting, failure investigation, lessons learned, safety, FOD control, process control, and infrastructure improvements to meet aggressive technical goals. Concepts and innovations for engine life testing, engine fault detection, flight qualification test practices, data reduction and uncertainty analysis methodologies, and other test needs to meet future demands are of interest.

Mission Area II: Liquid Combustion Subsystems and Components

Co-Chairs: Dr. Christopher S. Protz, NASA MSFC / Huntsville, AL
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Dr. Juliett Davitian, The Aerospace Corporation / El Segundo, CA
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Thrust Chamber Assembly (TCA) Design and Applications: This mission area addresses the components and subcomponent features required in all sizes of liquid rocket engines. Components include main combustion chambers, preburners, gas generators, nozzles, high temperature nozzles, and their subcomponent features including items such as injectors, stability aids, and coolant passages. Papers on combustion devices are being sought that cover all aspects of design analysis, component test results, test rig development, diagnostic techniques, and novel design features that are being made possible by manufacturing advances.

Hydrocarbon Fuel Properties, Performance, and Specifications and Processes: Papers addressing chemical composition, physical properties, fit-for-purpose quality, cooling and combustion performance, and specification for various hydrocarbon fuels, including RP-1/RP-2, methane, LNG, JP-10 and other high energy density propellants, and alternatively derived fuels (F-T, fIPK, ATJ, etc.); experimental and numerical efforts to characterize operational performance of these fuels in terms of cooling, combustion, and other application-specific processes.

Combustion Stability: Papers addressing design and performance challenges, modeling and simulation techniques, and scaling methods associated with combustion stability in main combustion chambers, preburners, and gas generators for all sizes of liquid rocket engines.

Liquid Injection Systems: The injection system of liquid rocket engines is critical to system performance. This mission area seeks papers describing new injector concepts, the physical processes required to understand injection concepts (including supercritical jets, sprays, and droplets), and methods to determine injector performance and stability.

Modeling and Simulation: Recent advances in modeling and simulation bring forward new capabilities to performance prediction and design of combustion devices. Papers are sought that look at the recent developments, new techniques, results of implementation or comparison with tests. Aspects covered include, but are not limited to: integrated models, injector element dynamics, hot gas flow fields, heat transfer, cooling mechanism, modeling of conventional and novel additively manufactured design features relative to coolant passages, hot wall features, injectors, etc.

Advanced Liquid and Gel Propellants: Papers are sought addressing advanced liquid and gel propellants and the development of supporting technologies such as "green" propellants, fuel management systems and lightweight tankage systems to advance state-of-the-art chemical capabilities.

Hybrid Rocket Engines: Papers addressing hybrid rocket engine systems and the combustion process in these systems.

Mission Area III: Liquid Propellant Feed and Pressurization Systems

Co-Chairs: Mr. James L. Cannon, NASA MSFC / Huntsville, AL
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Turbomachinery Design and Applications: Turbopump-fed liquid rocket engine systems require the use of high speed and high performance rotating machinery. Turbomachinery for this application requires support from a wide range of technical disciplines. Technical areas typically considered include the design, analysis, and testing of inducers, impellers, turbines, seals, bearings and structural elements. Papers on liquid rocket engine turbomachinery are being sought that cover all aspects of design, analysis, code development, component test results, test rig development, diagnostics techniques, and system level testing.

Pressurization and Feed Subsystem Design and Applications: This area covers all aspects of design, analysis and testing of the propellant feed system and engine system specific elements. The propellant feed system is composed of tanks, major component lines, pressurization systems, ducts, feed system control valves, and suppression systems. Engine system specific elements include ducts, flow measurement devices and valves. Papers are being sought which address design, analysis, tool development, diagnostics techniques, and testing of propellant feed system elements and engine system specific elements.

Electric Pump Systems: Advances in battery technology and electric motor technology have made it possible to use electric motors to drive propellant pumps. Electric pump systems have applications in rocket engines and propellant feed systems. Papers on electric pump systems are being sought that describe the unique flight system requirements, architecture, and design constraints. Also encompassing all aspects of the pump design, analysis, control system design, component test results, test rig development, diagnostics techniques, and system level testing.

Mission Area IV: Advanced Materials for Liquid Propulsion Applications

Co-Chairs: Mr. Clyde "Chip" Jones, NASA MSFC / Huntsville, AL
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Material Applications in Liquid Rocket Engines: Papers are sought addressing advanced materials and processing for liquid rocket propulsion systems, including:

- Material technologies resulting in significant thrust-to-weight ratio increases and/or performance advantages over state-of-the-art capabilities
- Lightweight, high-temperature nozzle materials
- Polymer matrix composites (PMCs) for lightweight components and structures
- PMC resin development for high-temperature or cryogenic environments
- Materials for lightweight lines, ducts, valves, and tanks
- Metals, ceramics, and their composites for component applications
- Materials and production methods for lower lifecycle costs
- Near net shape production for components and structures
- Modeling of materials for liquid rocket engines

Materials for Commercial Space Transportation: The recent shift by NASA to commercial space transportation to the ISS under COTS has created the need for low-cost, high performance material solutions for a new generation of space vehicle engines. Papers are sought addressing areas such as:

- Materials selection criteria
- Material characterization requirements
- Flight qualification standards for materials
- Risk management as related to materials selections

Heavy Lift Launch Vehicles: A need for heavy lift launch vehicles (>100 metric tons payload) has been identified for future space exploration and other missions. Such a launch vehicle will likely require engines in the 1 million pound thrust class as well as smaller upper stage and other liquid-fueled engines. Papers are sought addressing materials and processes for:

- Manufacturing and production of new liquid fueled engines
- Integrated health management for materials and structures
- Lightweight tanks and composite ducts
- Materials for reusable engines
- Concepts for material solutions that optimize the entire propulsion system for improved performance

Nanotechnology for Liquid Propulsion Systems: Application of new nanomaterials to liquid propulsion systems has the potential to greatly increase performance of future engines. Papers are sought to address:

- Nanomaterials and nanoprocessing to improve strength, conductivity, density, modulus, and other properties
- Concepts of how to integrate nanotechnology into future liquid-fueled rocket engines
- Nanotechnology areas that may have high payoffs for liquid rocket engine systems

Materials for Green Fuel Engines: In addition to the traditional hydrogen, hydrocarbon and hypergolic engines, new engines with "green" fuels such as methane and ethanol as well as newer fuels that go beyond the traditional definition of green fuels have been proposed. Little work has been done to address the compatibility of these fuels and their combustion products with current and potential future engine materials. Papers are sought to address:

- Environmental corrosion issues for both the fuels and the combustion products
- Compatibility test methods
- Materials concepts for future green fueled engines
- Concepts for future engines and materials for them

Turbomachinery Materials: Turbomachinery require new materials or coatings to address new engine cycles such as oxygen-rich staged combustion. The chemical and temperature environments will be considerably different than prior expander or gas-generator cycles. Papers are sought to address potential issues such as:

- Hydrogen and oxygen compatibility
- Testing for oxygen promoted combustion and hydrogen embrittlement
- Development process for new materials
- Criteria for inserting new materials into turbomachinery for hydrogen-, hydrocarbon- and green-fueled engines

Additive Manufacturing: Processing methods using additive manufacturing techniques such as selective laser sintering, electron beam sintering, UV additive manufacturing, microwave additive manufacturing and other three-dimensional rapid prototyping methods offer considerable potential for reduction of times to produce parts, cost savings and increased part complexity. Papers are sought for both the development of techniques and the practical use of additive manufacturing technologies as applied to liquid propulsion applications.

Liquid Propulsion Subcommittee Co-Chairs

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SPS MISSION AREAS

The 10th SPS seeks abstracts on the full array of spacecraft propulsion technology interests including chemical propulsion, electric propulsion, micropropulsion, nuclear thermal propulsion, propellant management, aerocapture, solar sails, solar thermal propulsion, tether systems, in-space propulsion infrastructure, and technologies for the future. Possible applications to these technologies are orbit to orbit transfer, attitude control, non-terrestrial ascent/descent, station keeping, deep space, formation flying, drag makeup, and orbital rephasing.

Mission Area I: Chemical Propulsion

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Papers are invited that cover all areas of chemical propulsion including monopropellant, bipropellant, gel, solid, and hybrid chemical propulsion systems. Some current areas of interest include, but are not limited to, advanced propellant formulations and propulsion system developments for modern spacecraft and new missions.

Decreased toxicity monopropellant thruster technology development has been of primary interest for spacecraft applications in the last decade. Monopropellant technology is of critical importance to spacecraft operations and principally relies upon catalyst technology.

New propulsion system architecture approaches and technology demonstrations that are being pursued to reduce cost, expand capabilities, and enable new missions are also of significant interest. Also, reuse or modification of existing propulsion systems and components has been an ongoing and emerging area of development where publications are sought. This includes the reuse of heritage components and developments in reusable vehicles, systems, or components.

Increasing community knowledge of lessons learned and the relative impact of forthcoming technologies and approaches will support the transition and evolution of these propulsion approaches. Papers are solicited on the following topics of particular interest for sessions supporting spacecraft chemical propulsion:

Propellant Factors -

- Propellant physical property characterization
- Formulation, pre-cursor considerations, synthesis, and quality control measures
- Propellant advantages, disadvantages and their impact to operations (ground and flight)
- Propellant (decreased toxicity and state of the art) storage and management
- Decomposition, kinetics, and combustion environment impact to materials and duty cycle
- Impact of propellant impurities on performance including catalytic life

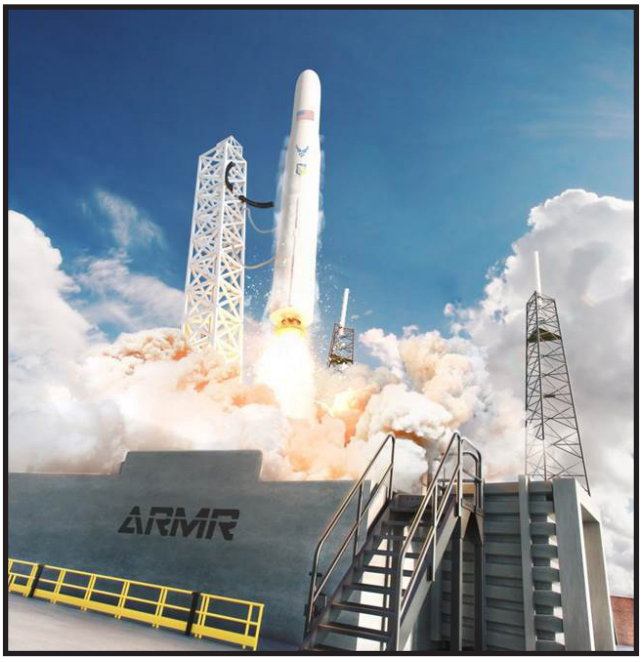
Thruster / Engine / Component Factors -

- Impact of propellant impurities on delivered performance including catalytic and non-catalytic reactor performance and life
- Injection technologies and concerns such as propellant atomization or dispersion, including impacts of non-volatile residue accumulation factors and irregular feed

- Decomposition and ignition means for all areas of chemical propulsion including:
  - Development and performance of alternative catalysts, substrate, and active materials with respect to response and life limiting factors
  - Augmented catalytic and non-catalytic decomposition for monopropellants
- Developments and issues in the reuse, modernization, and/or requalification of components
- Integrated performance and operations including:
  - Duty and thermal cycle impacts to response, repeatability, and useful life
  - Relationship of propellant conditions, component design, and ignition factors
  - Relationship of propulsion system conditioning requirements by mission
  - Effectiveness in modeling variation of performance for system design and mission planning

System / Mission Factors -

- Throttleable and pulsed system delivered performance including combustion stability effects
- Propulsion system architecture considerations, configuration trades, and mission optimization
- Propulsion system operations, diagnostics, and failure management
- Operational condition concerns such as conditioning of propellants and testing of environments
- Status, infusion viability, and impact of new propulsion technology and pathfinder activities



Mission Area II: Electric Propulsion

Co-Chairs: Dr. Hani Kamhawi, NASA GRC / Cleveland, OH
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Dr. Robert B. Lobbia, NASA JPL / Pasadena, CA
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Dr. Justin Koo, AFRL / Edwards AFB, CA
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Papers are invited in all areas of electric propulsion (including solar- and nuclear -powered systems). Topics of interest include:

- **Basic Research and Development of Electric Propulsion Thrusters:** This area includes physics of electric propulsion processes, thruster technology development, advanced and breakthrough concepts, high-power electric propulsion, hybrid and dual-mode systems using electric propulsion, alternate propellant research, laboratory plasma diagnostic techniques, and electric propulsion ground test facilities effects.
- **Systems Engineering of Electric Propulsion Subsystems:** This includes electric propulsion subsystem design, propellant storage and feed systems development, power processing units design and testing, and integrated system testing of electric propulsion subsystems.
- **Electric Propulsion Flight Programs and Mission Studies:** This includes reporting on: flight electric propulsion hardware development; ground and flight system operations; space qualification programs; flight plasma diagnostics development and experiments; in-flight programs status; electric propulsion mission studies for commercial, science, and human exploration space missions.
- **Electric Propulsion Modeling and Simulation:** This includes computational models for physical behavior, innovative numerical methods, development of robust computational validation techniques and exploitation of novel hardware configurations. This includes models and simulations supporting: electromagnetic and electrostatic thruster development; interrogation of ground facilities effects; prediction of plume signatures and spacecraft/plume interaction behavior.

Mission Area III: Cube / Nano Satellite Propulsion

Co-Chairs: Dr. Colleen M. Marrese-Reading, NASA JPL / Pasadena, CA
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Mr. Khary I. Parker, NASA GSFC / Greenbelt, MD
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Dr. William A. Hargus, Jr., AFRL / Edwards AFB, CA
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Papers are invited to discuss micro-propulsion for CubeSATS, NanoSATS, and other small satellites. Applications, concepts, and designs for propulsion systems or components for small satellites are of interest. Of particular interest are papers on components such as valves, tankage, propellant feed system elements, and power conditioning for micro-propulsion applications. Other areas of interest include:

- Micro-propulsion
- Nano-propulsion
- Micro-thrust devices
- Cube satellite applications
- Micro satellite applications
- Nano-satellite applications
- Cube/Micro/Nano satellite propulsion systems
- Small component development and design for small propulsion applications
- Power conditioning for micro-EP applications
- System-level integration studies
- Mission design studies
- Flight demonstrations

Mission Area IV: Future Technologies

Co-Chairs: Dr. George J. Williams Jr., NASA GRC / Cleveland, OH
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Dr. Kurt A. Polzin, NASA MSFC / Huntsville, AL
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Email: kurt.a.polzin@nasa.gov

Papers are invited for a range of advanced future space propulsion technologies, including but not limited to the following listed areas.

Nuclear Thermal Rocket (NTR) propulsion design, testing, and utilization for future human exploration missions of the solar system, including:

- NTR spacecraft and mission design for human Mars Exploration mission
- Solid core NTR concepts with or without bimodal capability
- Common reactor design for both propulsion and surface power generation
- Candidate nuclear fuel options
- Reactor controls and shielding
- NTR test methods and facilities
- NTR demonstration options
- Safety, reliability, risk analysis and crew-rating
- NTR vehicle operations and costs
- Planned and/or funded missions
- Near-term mission concepts
- Innovative system or subsystem designs

Advanced concepts for both near- and far-term future space propulsion focusing on technologies that promise significant gains in specific impulse, and/or power density, but are based on known fundamental physics, such as:

- Fusion energy in space propulsion including conventional magnetic schemes, inertial fusion schemes, inertial electrostatic confinement, magnetically insulated inertial fusion, fission-fusion hybrid systems, and concepts that utilize fusion reaction directly or indirectly.
- Laser or microwave propulsion
- Solar sail propulsion, electrodynamic and momentum exchange tether propulsion, and other innovative technologies that use the natural environments of space to derive propulsion without the expenditure of conventional fuel.

Spacecraft Propulsion Subcommittee Chair

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Spacecraft Propulsion Subcommittee Deputy Chair

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JHU WSE ERG Technical Representative

Mr. David Owen, JHU WSE Energetics Research Group / Columbia, MD
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WORKSHOPS/SPECIALIST SESSIONS

Recommendations for workshops or specialist sessions are solicited at this time. **Individuals interested in organizing and chairing a workshop or specialist session should contact the JHU WSE ERG Technical Staff member in their respective subcommittee by the Extended Deadline of 8 July 2019**.

Workshops

The JANNAF Workshop is reserved for bringing the community together to address a specific task or problem, the outcome of which is important and substantial enough to warrant the publication of a final report detailing the discussions, conclusions, and recommendations that resulted from the workshop.

Requirements for JANNAF workshops and established best practices can be found in the JANNAF Workshop Guide for Chairs; this document will guide you through the planning and approval process for workshops held at a JANNAF meeting.

To request a workshop you must submit a Workshop Request Form to your JHU WSE ERG Technical Representative (see pages 5-12 for contact information) or the JANNAF Meeting Planning Team at meetings@erg.jhu.edu. This form must be submitted to ERG by **Monday, 8 July 2019**. The agenda and invitation list is due **Monday, 2 September 2019** for inclusion in the Preliminary Program, and must be approved no later than **Monday, 28 October 2019** for inclusion in the Final Program.

Specialist Sessions

A JANNAF specialist session is an opportunity for experts in a specific technical area to meet to stimulate ideas and contributions from the audience. These sessions are dedicated to a single topic and often include invited presentations. The organization of these sessions is similar to a regular JANNAF paper session with time allocated to individual presentations; however, specialist sessions often include moderator led discussion periods or a question and answer session with expert panelists. Unlike a regular JANNAF paper session, the presentations from specialist sessions may or may not be published as part of the meeting proceedings. Publication can include an executive summary authored by the session chair if desired.

To request a Specialist Session for this JANNAF meeting, a Specialist Session Request Form must be submitted to JHU WSE ERG. This form requires a statement of justification for the Specialist Session along with a well thought out agenda. Requests will be reviewed by the designated JANNAF subcommittee TSG chair and ERG for approval; this approval is necessary for any Specialist Sessions to be included in the Final Program.

The extended deadline for submission of a Specialist Session request is 8 July 2019, and forms must include a draft agenda. If you have any questions about planning a Specialist Session please contact your ERG Technical Liaison or the JANNAF Meeting Planning Team at meetings@erg.jhu.edu.

JANNAF AWARDS PROGRAM

In the tradition of recognizing the outstanding achievements by members of the propulsion community, the JANNAF Technical Executive Committee (TEC) and Programmatic and Industrial Base Committee (PEC), as well as the Modeling and Simulation (MSS), Liquid Propulsion (LPS), and Spacecraft Propulsion (SPS) subcommittees, are soliciting nominations for awards to be presented at the meeting. A TEC or PEC Award is justified if the achievement or service is in a technical or programmatic area that is not covered by an existing subcommittee, or is of such scope or magnitude that merits this recognition.

Special Recognition Awards

The **Special Recognition** awards for **Sustained Contribution** and **Lifetime Achievement** honor individual achievements, either in the last 18 months or for a lifetime of dedicated service. These awards are the most prestigious subcommittee awards and reflect on the awardees' contributions to JANNAF.

Special recognition award winners will be selected by respective subcommittee Awards Committees based on review of the nomination in consideration of the following:

- Technical value of the achievement(s) including level of technical complexity and challenge, quality of results, degree of innovation and timeliness of research.
- Impact of the achievement on the broader propulsion community.
- For individuals nominated for lifetime achievement, demonstrated participation in technical societies as evidenced by positions held and papers published will be considered favorably.

Outstanding Achievement Award

The **Outstanding Achievement Award** is given for the most outstanding technical achievement in the subcommittee's area by an individual, by a team within an organization, or by a team of organizations. To recognize the varied nature of the JANNAF subcommittees and the accomplishments of their communities, nominations may be solicited and given in the two focus areas of R&D Technology and Operational Systems.

- The achievement shall have been accomplished in the previous 18 months.
- The nominees must have worked for the organization during the same 18-month period of performance.

Certificate of Commendation

The **Certificate of Commendation** is given to recognize an individual whose contributions within the last 18 months have been pivotal in ensuring the success of a JANNAF activity.

Certificate of Appreciation

The **Certificate of Appreciation** is given to recognize individuals for outstanding contributions and dedicated service to JANNAF.

Nominations

To nominate an individual for one of the above awards please use the JANNAF TEC/PEC and Subcommittee Award Nomination Form. Nomination submissions should include the following:

- A description of the achievement or distinguished service, of no less than 200 and no more than 1000 words. The description must be typed or provided in electronic format (Adobe Acrobat PDF or MS Word) via email.
- Supporting data (if desired) of no more than 10 pages.
- Supporting curriculum vitae, list of publications, and/or professional activities as required to support the nomination.
- Contact information for the nominee(s) and the nominator, including organization affiliation, phone number, and email address.

Nominations should be submitted to the appropriate JHU WSE ERG technical representative no later than **Monday, 7 October 2019**.

Best Paper Awards

In addition to the nomination awards listed above JANNAF recognizes authors of papers that exhibit excellence and significant merit with the **Best Paper Awards**. Best Paper Awards from this meeting will be given at the next JANNAF Subcommittee meeting.

Best Student Paper Awards

The **Best Student Paper Award** will be given to undergraduate or graduate students who author papers that exhibit excellence and significant merit. One paper will be selected to receive the Best Student Paper Award. If requested on the Abstract Submittal Form, student-authored works will be included in the initial round of consideration with the submission of an abstract; please be sure to indicate on the Abstract form if you wish to be considered for the Best Student Paper Award. Please note that a student must be the paper's primary author to be considered for this award.

As a reminder: student authors must conform to the same JANNAF eligibility requirements as other authors, per the policy on non-government attendees at JANNAF meetings given on page 2. Student authors are encouraged to work with their advisors to ensure they meet these requirements, and should contact the JANNAF Security Team (Mary Gannaway at mtg@jhu.edu or Tricia Reider at treider@erg.jhu.edu) at their earliest convenience with questions regarding their eligibility and participation.

Student papers will be reviewed upon submission of their cleared manuscripts. In order to be considered for the student best paper selection, the completed paper must be provided to JHU WSE ERG by **7 October 2019**. The Best Student Paper Award will be presented at the JANNAF meeting at which the paper is given.

UPCOMING JANNAF MEETINGS

66th JANNAF Propulsion Meeting
Programmatic and Industrial Base Meeting
49th Combustion
37th Airbreathing Propulsion
37th Exhaust Plume and Signatures
31st Propulsion Systems Hazards
Joint Subcommittee Meeting
3-7 June 2019
Dayton, OH
Visit June 2019 meeting website

13th Modeling and Simulation
11th Liquid Propulsion
10th Spacecraft Propulsion
Joint Subcommittee Meeting
Programmatic and Industrial Base Meeting
9-13 December 2019
Florida Location TBA
Visit December 2019 meeting website

67th JANNAF Propulsion Meeting
Programmatic and Industrial Base Meeting
46th Structures and Mechanical Behavior
42nd Propellant and Explosives Development and Characterization
33rd Rocket Nozzle Technology
31st Safety and Environmental Protection
Joint Subcommittee Meeting
Spring 2020